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# PATENT SPECIFICATION

741,302



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## COMPLETE SPECIFICATION.

### Improvements in or relating to Apparatus and Methods for Welding Metal Tubes.

5 We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London. W.C.2, a British Company, and JAMES ARTHUR DONELAN, of Research Laboratories, The General Electric Company Limited, Wembley, Middlesex, a British Subject, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

The present invention relates to apparatus and methods for electric arc welding a seam in a metallic tube.

15 It has been proposed that a tube should be manufactured from strip material by bending the strip progressively to form an open tube the edges of the strip material subsequently being welded together to form a closed tube. 20 The welded seam may extend longitudinally along the length of the tube, or if desired it may extend helically along and around the tube.

25 According to one aspect of the present invention, in apparatus for electric arc welding a seam extending along a metal tube comprises means for moving the tube to be welded past a normally stationary welding torch to cause the seam to be welded to pass in welding 30 association with the torch, the welding torch is so mounted that it is movable in the direction of movement of the tube from a normal welding position to a temporary position or positions at which starting or re-starting of welding is arranged to be initiated.

35 According to another aspect of the present invention in a method of electric arc welding a seam extending along a tube in which the tube is arranged to move past a normally stationary welding torch, after the welding current has been established, the welding torch is arranged to be moved in a direction of movement parallel to the direction of

movement of the tube for starting or re-starting of welding.

45 When welding of a seam is to be re-started it is desirable that a short length of the seam should be welded again in order to avoid the formation of an unwelded zone. In order to effect this, the welding torch may be displaced in the direction of movement of the tube so as to bring the torch over a welded portion of the seam close to the end of the region in which welding has been effected. 50 The tube to be welded is then caused to move past the welding torch during welding so that a short length of the seam is welded again. Thereafter the welding torch is gradually moved in a direction opposite to that of the movement of the tube until it reaches its normal position. The movement of the welding torch in the direction opposite to the direction of movement of the tube can be effected manually if desired but preferably such movement is arranged to be effected 55 automatically at a slow speed compared with the speed of movement of the tube. For example, the speed of movement of the welding torch may be arranged to be of the order of a few per cent or up to, say, 10% of the speed of movement of the tube. This slow speed of movement of the welding torch is necessary in order that the heat input to the seam during welding while the welding torch is moving may not be greatly less than the heat input under normal conditions of welding 60 when the welding torch is stationary. A feature of this invention, however, consists in providing means for increasing the welding current during the period that the welding torch is moving in order to compensate for the greater speed of movement of the torch relatively to the tube. 65

One arrangement in accordance with the present invention as applied to the welding of a straight longitudinal seam in a tube will 70 75 80 85

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now be described by way of example with reference to the accompanying drawings in which:—

Figures 1 and 2 are side elevational and plan views respectively showing the welding torch in the normal position;

Figure 3 is a plan view showing the welding torch in the position for re-starting welding of a tube;

Figure 4 is a similar view showing the welding torch in the position for starting welding of a tube; and

Figure 5 is a somewhat simplified diagram of the electrical connections of the apparatus.

Referring to the drawings an open tube 15 which has been formed by bending a strip of metal such for example as aluminium, has a longitudinal seam weld 7 effected by a welding torch 8 which may for example be of the argon shielded arc type. The welding torch 8 may be of a type having a single electrode arranged to be fed with single-phase alternating current or if desired it may be of a type having two electrodes arranged to be fed with two-phase or three-phase alternating current, the common return line or third phase as the case may be being connected to the tube to be welded. In the arrangement described herein two-phase welding current providing two working areas, is used. During normal welding, that is to say, during welding after an initial starting or re-starting period, the welding torch is maintained stationary in the position shown in Figures 1 and 2, in relation to two pairs of shaped rolls, one pair of rolls 5 and 6 acts on the tube after welding while the other pair 3 and 4 acts on the open tube a short distance before the normal position of the welding torch as shown in Figure 2. The welding torch 8 is mounted on an arm 12 adjustably supported by a carriage 9 having wheels 10 movable along rails 11 which extend parallel to the direction of movement of the tube so that the welding torch 8 can be moved in the direction of movement of the tube. It will be appreciated that provision may be made for adjusting the position of the welding torch 8 in two directions transversely of the direction of movement of the tube so that the welding arc is positioned correctly in relation to the seam to be welded.

During re-starting of welding the welding torch is moved on its carriage to a position as shown in Figure 3 to bring the torch 8 into a position in which it lies in welding association with a part of the seam 7 which has already been welded so that on re-starting a short length of the seam is re-welded. For example, if the tube is arranged to move past the welding torch at a speed of the order of, say, three to six feet per minute, the welding torch may be positioned a few inches from the end of the already welded seam. Preparatory to the re-striking of the welding arc the

drive (not shown) for causing the tube to travel past the welding torch 8 is brought up to speed so that at the instant when the welding arc is initiated the tube is travelling at about its normal speed. After the welding arc has been re-established the carriage 9 is moved along the rails 11 by means of an electric motor 18 hereinafter referred to as a tractor motor in the direction opposite to the direction of movement of the tube to return the welding torch 8 to its normal position. As above mentioned, the speed of movement of the welding torch should be of the order of a few per cent of the speed of movement of the tube. When the welding torch has reached its normal position as shown in Figures 1 and 2 the carriage 9 is stopped and it is maintained in this position until it is necessary again to start or re-start the welding operation.

For starting welding of an unwelded open tube a slightly different technique is desirable owing to the fact that except in the positions in which the edges of the open tube are pressed together and supported by the guiding rolls 3 and 4 or 5 and 6 there is a tendency for the edges to separate. For this reason when starting the welding of an open tubular sheath the welding torch 8 is moved on its carriage so that it occupies a position, as shown in Figure 4, in which welding can be started on a portion of the open tube closely adjacent to the pair of rolls 5 and 6 which maintain the edges of the tube in contact or at least in close proximity. When welding has been established, the solidification of the just-welded metal exerts a drawing action which maintains the edges of the open tube together so that welding can be effected at a greater distance from a pair of rolls and the welding torch is therefore progressively returned to its normal position intermediate between the two pairs of rolls as shown in Figures 1 and 2. Figure 5 shows a circuit diagram of some of the electrical apparatus used in one arrangement in accordance with the present invention. The tube is arranged to be moved past the welding torch 8 by an electric motor 21 which can be connected to a three-phase supply 20 by a contactor 22 having an operating winding 23. If necessary the edges of the strip material to be welded may be sheared or cleaned, for example by scratch brushing, before the strip material is formed into the open tube. Starting of welding is initiated by energising the operating winding 23 of the contactor 22 to start the electric motor 21 for moving the tube past the welding torch 8. The control circuit for energising this operating winding 23 may include switches responsive for example to the flow of cooling water or shielding gas such as argon if a gas shielded arc is used. At the same time as the motor 21 for moving the tube past the welding torch is

started, the means for cleaning the edges of the strip material (if provided) are set in operation. When the motor for moving the tube past the welding torch has reached its normal speed a switching operation is effected to energise the operating winding 26 of a contactor 25 controlling the supply of three-phase current to a three-to-two-phase transformer 27 feeding two-phase current through chokes 44 to the welding torch 8. The tube 2 is connected to the common return line 31 of the welding current supply, the common return line including a current transformer 32 feeding a bridge connected rectifier 33 which feeds the operating winding 30 of a relay. This relay has a normally open contact 29 arranged in the supply circuit for the variable speed tractor motor 18 which is fed through an isolating switch 34 and variable transformer 28 from between two phases of the three-phase supply 20. This circuit also includes a limit switch 19 which is opened when the carriage and torch are in the "normal" position. When the welding arc or arcs is or are established there is a flow of welding current in the welding circuit through the line 31 and the current transformer 32 in this circuit which is arranged to energise the operating winding 30 to complete the circuit for supplying current to the tractor motor 18 which is arranged to cause the carriage to return at a slow speed to its normal position. When the carriage has returned the welding torch to its normal position the limit switch 19 causes the tractor motor and carriage to stop so that the carriage is held in its normal position during welding.

To start the welding of a seam in a tube the procedure is as described above except that the welding torch is initially positioned as shown in Figure 4 in welding association with a part of the seam to be welded where the edges of the strip material are held together by the pair of rolls 5 and 6.

In the arrangement shown in Figure 5 provision is made for adjusting the value of the welding current.

An induction regulator 24 is provided in series with the three-to-two-phase transformer 27. The induction regulator 24 is operated by a reversible alternating current electric motor 35 which can be connected to the three-phase supply 20 through a contactor 36 or a contactor 37, these contactors being arranged to give opposite senses of phase rotation. The contactor 36 has an operating winding 38 which can be energised by pressing a push button 40 provided a limit switch 42 connected in series therewith is not open. Similarly the contactor 37 has an operating winding 39 which can be energised by pressing a push button 41 connected in series with a limit switch 43. The limit switches 42 and 43 are arranged to be opened when the induc-

tion regulator 24 reaches appropriate limiting positions. In order to increase the welding current one of the push buttons, for example the push button 40, is pressed causing the motor 35 to rotate in one direction, while to decrease the welding current the other push button 41 is pressed to cause the motor 35 to rotate in the opposite direction. Interlocking contacts are provided to prevent simultaneous operation of both the contactors 36 and 37. When a desired value of welding current is reached the push buttons 40 and 41 are released so that both the contactors 36 and 37 are opened so that the motor 35 and induction regulator 24 remain stationary. This arrangement can be used to alter the magnitude of the welding current during welding and can also be used as a preliminary to the starting or re-starting of welding to set the position of the induction regulator 24 so that when welding is started or restarted the welding current will be increased by an amount which is appropriate to the increased speed of movement of the welding torch relatively to the tube as a result of the action of the tractor motor 18 moving the carriage 9. It is to be mentioned that in the Specification of co-pending Patent Application No. 30674/52 (Serial No. 741,303) there is described and claimed apparatus for welding together the edges of a metal strip formed to constitute a sheath for an electric cable by movement of the said strip past a normally stationary welding torch, having mounting means permitting the welding torch to be bodily moved in the direction of the seam at which the edges of the strip are united, but it is to be understood that the invention described and claimed in the present Specification, in which similar apparatus is employed to that according to the said co-pending Application, is limited solely to apparatus for electric arc welding a seam extending along a metal tube.

What we claim is:—

1. Apparatus for electric arc welding a seam extending along a metal tube comprising means for moving the tube to be welded past a normally stationary welding torch to cause the seam to be welded to pass in welding association with the torch, wherein the welding torch is so mounted that it is movable in the direction of movement of the tube from a normal welding position to a temporary welding position or positions at which starting or restarting of welding is arranged to be initiated.

2. Apparatus according to Claim 1, wherein movement of the welding torch upon starting or re-starting of welding back to its normal welding position is arranged to be effected automatically in response to starting or re-starting of welding.

3. Apparatus according to Claim 1 or 2, wherein movement of the welding torch upon

starting or re-starting of welding back to its normal welding position is arranged to be effected at a slow speed compared with the speed of movement of the tube to be welded.

4. Apparatus according to Claim 3, wherein the said slow speed of movement of the welding torch is arranged to be less than ten per cent of the speed of movement of the tube.

5. Apparatus according to any of the preceding claims, wherein the welding torch is mounted on a carriage capable of movement along a support extending in a direction parallel to the seam to be welded.

6. Apparatus according to Claim 5, wherein movement of the carriage is arranged to be effected by an electric tractor motor.

7. Apparatus according to Claim 6, wherein a limit switch is included in the circuit for supplying the electric tractor motor, said switch being opened when the welding torch is in its normal position.

8. Apparatus according to Claim 7, wherein the electric tractor motor is a variable speed motor.

9. Apparatus according to any of the preceding claims, wherein provision is made for increasing the welding current during starting and re-starting.

10. Apparatus according to Claim 9, wherein adjustment of the magnitude of the welding current is arranged to be effected manually.

11. A method of electric arc welding a seam extending along a tube in which the tube is arranged to move past a normally stationary welding torch, wherein after the

welding current has been established the welding torch is arranged to be moved in a direction parallel to the direction of movement of the tube for starting or restarting of welding.

12. A method according to Claim 11, wherein for re-starting of welding the welding torch is arranged to be displaced from its normal position to a position in which it is in welding association with a part of the tube or the like which has already been welded.

13. A method according to Claim 11, wherein for starting of welding the welding torch is arranged to be displaced into a position in welding association with a part of the tube adjacent to where it is supported by guiding means.

14. A method according to any of Claims 11, 12 or 13, wherein during movement of the welding torch the welding current is increased by an amount sufficient to compensate for the effect of the temporarily augmented rate of relative movement between the tube or the like and the welding torch.

15. Apparatus for welding together the edges of a bent-up metal strip to form a tube constructed and arranged to operate substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

16. A method of welding together the edges of a bent-up metal strip to form a tube substantially as hereinbefore described.

For the Applicants:—

F. S. PEACHEY,  
Chartered Patent Agent.

#### PROVISIONAL SPECIFICATION.

#### Improvements in or relating to Apparatus and Methods for Welding Metal Tubes.

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British Company, and JAMES ARTHUR DONELAN, of Research Laboratories, The General Electric Company Limited, Wembley, Middlesex, a British Subject, do hereby declare this invention to be described in the following statement:—

The present invention relates to apparatus and methods for electric arc welding a seam in a metallic tube.

It has been proposed that a tube should be manufactured from strip material by bending the strip progressively to form an open tube the edges of the strip material subsequently being welded together to form a closed tube. The welded seam may extend longitudinally along the length of the tube, or if desired it may extend helically along and around the tube.

According to one aspect of the present invention apparatus for electric arc welding a seam extending along a metal tube or the like comprises means for moving the tube to be welded past a normally stationary welding torch to cause the seam to be welded to pass in welding association with the torch, said welding torch being movable in the direction of movement of the tube for starting and re-starting of welding.

According to another aspect of the present invention in a method of electric arc welding a seam extending along a tube or the like in which the tube is arranged to move past a normally stationary welding torch, the welding torch is arranged to be movable in the direction of movement of the tube for starting or re-starting of welding.

When welding of a seam is to be re-started it is desirable that a short length of the seam

should be welded again in order to avoid the formation of an unwelded zone. In order to effect this the welding torch may be moved manually or automatically in the direction of movement of the tube so as to bring the torch over a welded portion of the seam close to the end of the region in which welding has been effected. The tube to be welded is then caused to move past the welding torch during welding so that a short length of the seam is welded again. Thereafter the welding torch is gradually moved in a direction opposite to that of the movement of the tube until it reaches its normal position. The movement of the welding torch in the direction opposite to the direction of movement of the tube can be effected manually if desired but preferably such movement is arranged to be effected automatically at a slow speed compared with the speed of movement of the tube. For example, the speed of movement of the welding torch may be arranged to be of the order of a few per cent or up to, say, 10% of the speed of movement of the tube. This slow speed of movement of the welding torch is necessary in order that the heat input to the seam during welding while the welding torch is moving may not be greatly less than the heat input under normal conditions of welding when the welding torch is stationary. A feature of this invention, however, consists in providing means for increasing the welding current during the period that the welding torch is moving in order to compensate for the greater speed of movement of the torch relatively to the tube.

In one arrangement in accordance with the present invention as applied to the welding of a straight longitudinal seam in an open tube which has been formed by bending a strip of metal such for example as aluminium, welding is effected by a welding torch which may for example be of the argon arc type. The welding torch may be of a type having a single electrode arranged to be fed with single-phase alternating current or if desired it may be of a type having two electrodes arranged to be fed with two-phase or three-phase alternating current, the common return line or third phase as the case may be being connected to the tube to be welded. During normal welding, that is to say, during welding after an initial starting or re-starting period, the welding torch is maintained stationary in relation to two pairs of shaped rolls, one of which acts on the tube after welding while the other acts on the open tube a short distance before the normal position of the welding torch. The welding torch is mounted on a carriage movable along rails which extend parallel to the direction of movement of the tube so that the welding torch can be moved in the direction of movement of the tube. It will be appreciated that if desired provision may be made for adjusting the

position of the welding torch in two directions transversely of the direction of movement of the tube so that the welding arc is positioned correctly in relation to the seam to be welded.

During re-starting of welding the welding torch is moved on its carriage to bring the torch into a position in which it lies in welding association with a part of the seam which has already been welded so that on re-starting a short length of the seam is re-welded. For example, if the tube is arranged to move past the welding torch at a speed of the order of, say, three to six feet per minute, the welding torch may be positioned a few inches from the end of the already welded seam. Preparatory to the re-striking of the welding arc the drive for causing the tube to travel past the welding torch is brought up to speed so that at the instant when the welding arc is initiated the tube is travelling at about its normal speed. After the welding arc has been re-established the carriage is moved on its rails in the direction opposite to the direction of movement of the tube to return the welding torch to its normal position. As above mentioned, the speed of movement of the welding torch should be of the order of a few per cent of the speed of movement of the tube. When the welding torch has reached its normal position the carriage is stopped and it is maintained in this position until it is necessary again to start or re-start the welding operation.

For starting welding of an unwelded open tube a slightly different technique is desirable owing to the fact that except in the positions in which the edges of the open tube are pressed together by the shaped rolls there is a tendency for the edges to separate. For this reason when starting the welding of an open tubular sheath the welding torch is moved with its carriage so that it occupies a position in which welding can be started on a portion of the open tube between or closely adjacent to a pair of rolls which maintain the edges of the tube in contact or at least in close proximity. When welding has been established, the solidification of the just-welded metal exerts a drawing action which maintains the edges of the open tube together so that welding can be effected at a greater distance from a pair of rolls and the welding torch is therefore progressively returned to its normal position intermediate between the two pairs of rolls.

In one form of apparatus in accordance with the present invention the tube is arranged to be moved past a welding torch by an electric motor which is brought up to speed by a motor starter, for example of the contactor type. If necessary the edges of the strip material to be welded may be sheared or cleaned, for example by scratch brushing, before the strip material is formed into the

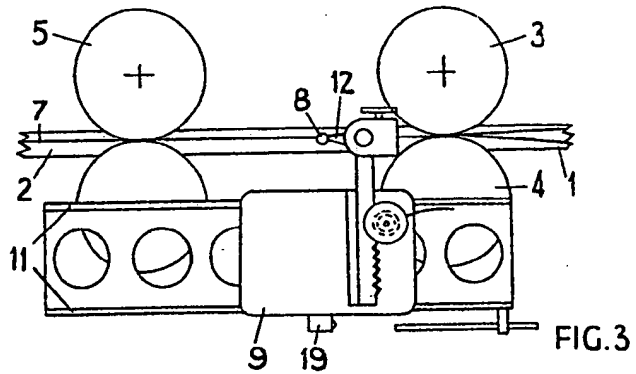
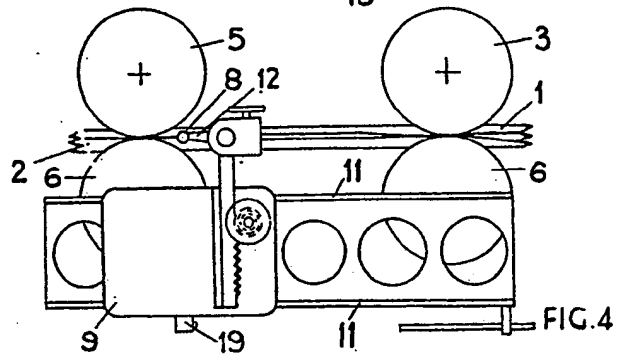
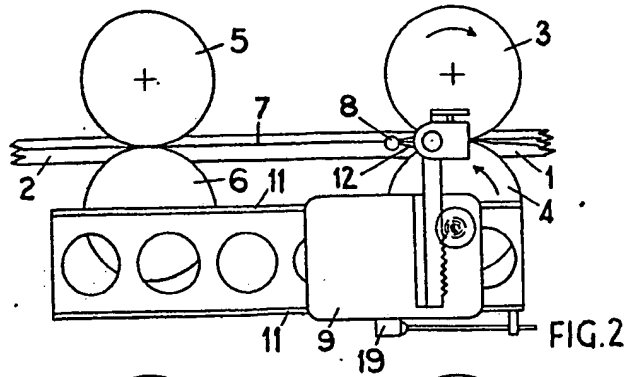
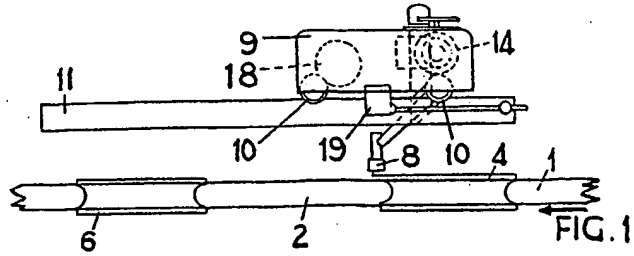
open tube. As a preliminary to the re-starting of a welding operation the welding torch is moved to a position in which it lies in welding association with a part of the seam which has already been welded. Re-starting of welding is effected by energising the contactors controlling the starting of the electric motor for moving the tube past the welding torch. The control circuit for energising this contactor may include switches responsive for example to the flow of cooling water or shielding gas such as argon if a gas shielded arc is used. At the same time as the motor for moving the tube past the welding torch is started, the means for cleaning the edges of the strip material are set in operation. When the motor for moving the tube past the welding torch has reached its normal speed a switching operation is effected to connect the supply of welding current to the welding torch and a welding arc is initiated for example by applying a voltage surge to the gap between the electrode and the tube to cause ionisation of the gap. When the welding arc or arcs is or are established there is a flow of welding current in the welding circuit through a current transformer in this circuit which is arranged to operate a relay which performs two functions. One of these functions is to close contacts in a tripping

circuit for the contactors for effecting starting of the electric motor for moving the tube past the welding torch so as to maintain the contactors in the running position while welding current flows in the welding circuit. The second function of the relay is to complete a circuit for supplying current to an electric motor arranged to cause the carriage to return at a slow speed to its normal position. When the carriage has returned the welding torch to its normal position it is arranged to open a limit switch to cause the tractor motor and carriage to stop so that the carriage is held in its normal position during welding. In the event of a failure in the current in the welding circuit the motor for moving the tube past the welding torch is stopped. This action can also be effected in the event of other abnormalities such as the stopping of the flow of cooling water.

To start the welding of a seam in a tube the procedure is as described above except that the welding torch is initially positioned in welding association with a part of the seam to be welded where the edges of the strip material are held together by a pair of rolls.

For the Applicants :—

F. S. PEACHEY,  
Chartered Patent Agent.



741,302 COMPLETE SPECIFICATION  
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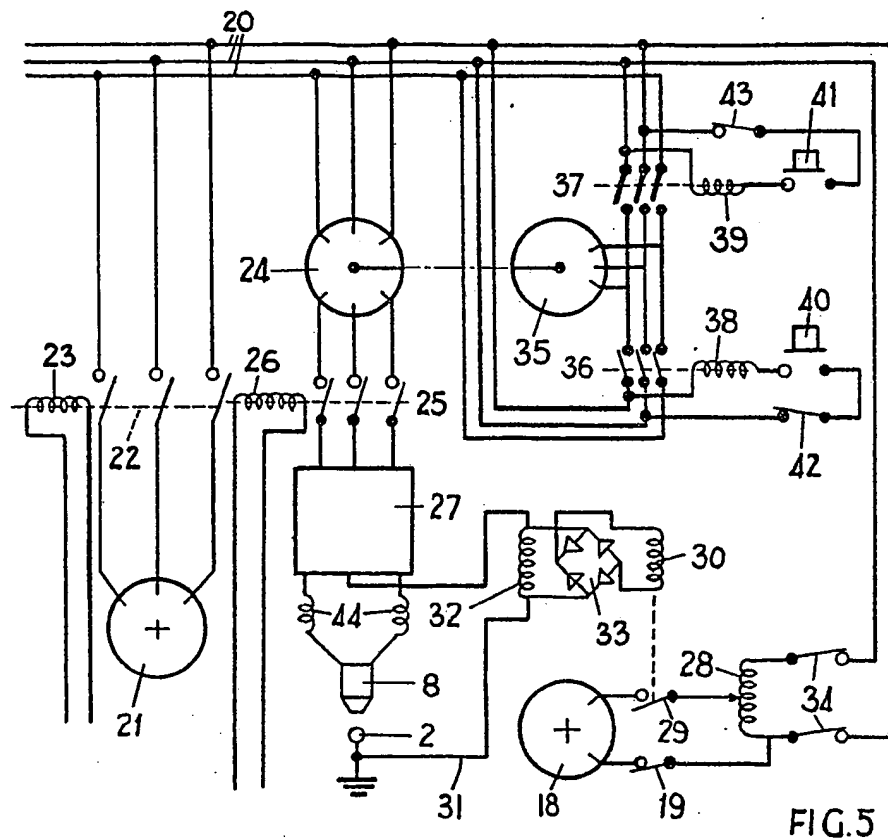


FIG.5

